Automated Operations Development for Advanced Exploration Systems

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Abstract – Automated space operations command and control software development and its implementation must be an integral part of the vehicle design effort. The software design must encompass autonomous fault detection, isolation, recovery capabilities and also provide "single button" intelligent functions for the crew. Development, operations and safety approval experience with the ***Timeliner*** system on-board the International Space Station (ISS), which provided autonomous monitoring with response and single command functionality of payload systems, can be built upon for future automated operations as the ISS Payload effort was the first and only autonomous command and control system to be in continuous execution (6 years), 24 hours a day, 7 days a week within a crewed spacecraft environment. Utilizing proven capabilities from the ISS Higher Active Logic (HAL) System [1], along with the execution component design from within the HAL 9000 Space Operating System [2], this design paper will detail the initial HAL System software architecture and interfaces as applied to NASA's Habitat Demonstration Unit (HDU) in support of the Advanced Exploration Systems, Autonomous Mission Operations project. The development and implementation of integrated simulators within this development effort will also be detailed and is the first step in verifying the HAL 9000 Integrated Test-Bed Component [2] designs' effectiveness. This design paper will conclude with a summary of the current development status and future development goals as it pertains to automated command and control for the HDU.

REFERENCES

[1] Stetson, H. K.; Deitsch, D. K.; Cruzen, C. A., Haddock, A. T.; "Autonomous Operations Onboard the International Space Station," IEEE Aerospace Conference, Big Sky, Montana, March 2007.

[2] Stetson, H. K.; Knickerbocker, G. K.; Cruzen, C. A., Haddock, A. T.; "The HAL 9000 Space Operating System," IEEE Aerospace Conference, Big Sky, Montana, March 20011.

Angie T. Haddock *is employed by NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama, in the Mission Operations Lab. Currently, Ms. Haddock is the Co-Lead of the MSFC Advanced Exploration Systems-Autonomous Mission Operations (AES-AMO), and an analyst for the Space Launch Systems (SLS) Flight Operations. In the SLS position, she has worked with the analysis and development of the SLS Flight Operations Specification and supported the analysis and documentation of requirements and Launch Commit Criteria derived from the vehicle system. Preceding the SLS and the AES projects, Ms. Haddock was the Operations Lead for the ISS PLMDM. In this role, she was responsible for leading the development of PLMDM operations, technical coordination for*

the development and update of PLMDM software. Prior to joining NASA in 2000, she worked for Teledyne Brown Engineering, where she trained to serve as a Command and Payload MDM Officer (CPO) for the ISS Payload Operations Integration Center. She holds a Bachelor of Science degree in Computer Science from Athens State University. Ms. Haddock, and her husband, Stacey, have three daughters; Stephanie, Mary Elizabeth & Amy.

Howard K. Stetson *is a contractor for Marshall Space Flight Center, Space Systems Operations and is currently working as an analyst for the Space Launch Systems (SLS) flight operations, avionics and software, as well as the Advanced Exploration Systems-Autonomous Mission Operations project and has over 34 years of experience in software development and engineering, encompassing numeric intensive computing, parallel processing, computer graphics, simulation and modeling, computational fluid dynamics, real-time C&C operations, operations automation, and software integration and test. Preceding the SLS and AES projects, Mr. Stetson designed, developed and implemented the Higher Active Logic (HAL) autonomous system for ISS payloads. Mr. Stetson, an employee of Teledyne Brown Engineering, has produced three white papers for the Marshall Space Flight Center, the Higher Active Logic System (HAL) for the ISS payload operations computer system, the Automated Multi-Purpose Space Operating System (AMPSOS) and the HAL 9000 Space Operating System design. Mr. Stetson is also a member of the United States Parachute Association and has over 3000 jumps to date.*